

Melles Griot Catalogue  
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## Laser Scan System Selection

Melles Griot is the leading designer and manufacturer of high performance laser scan lenses. The majority of these lenses are custom designed specials for OEM customers but a useful range of standard scan lenses are available from stock and are described in detail in this chapter. Special designs are available in both prototype and production quantities from Melles Griot Rochester in Rochester, New York.

In this section of the guide, we describe some of the important parameters involved in choosing or specifying a scan lens, followed by a listing of our more popular designs which are available as catalog items.

### LASER SCAN SYSTEM SELECTION

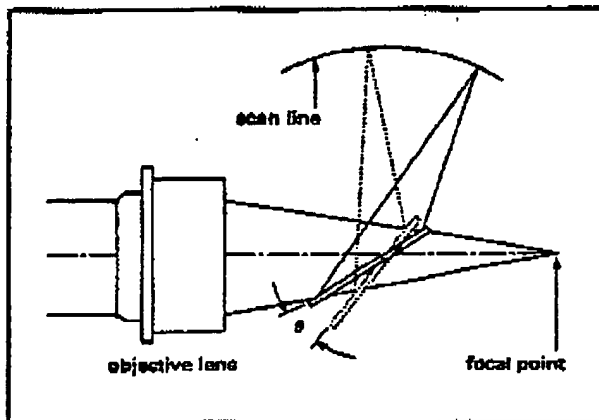
Because of the monochromaticity and coherence of a laser, it is possible to focus the beam to a diffraction limited spot yielding high energy densities and excellent spot uniformity. When this spot is made to sweep across an image surface which is sensitive to the radiation incident on it, image elements can be recorded. By looking at the reflected light, image elements may be read from the focal plane.

Laser scan systems may be classified as either post-objective or pre-objective scanners. Post-objective scanning is characterized by a curved image plane which is useful for some applications. The post-objective scan lens requires only a well corrected axial image spot

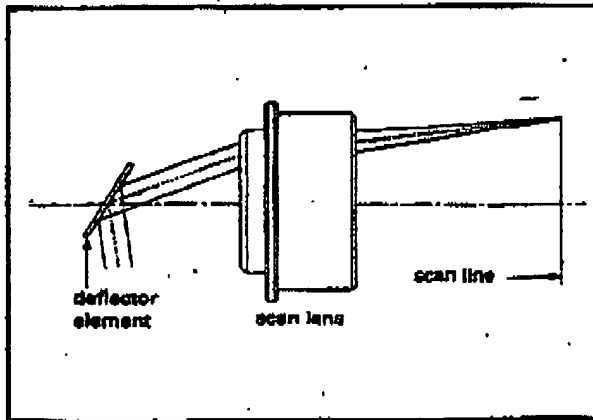
and, as a result, is a fairly straight forward optical design problem. A pre-objective scanning configuration, on the other hand, allows one to scan a flat image plane. The scan lens required to do this is more difficult to design than the post-objective lens, but has many more useful applications.

Pre-objective laser scan systems are found in applications ranging from graphic arts to semiconductor manufacturing. Flat field scan systems are found in devices as diverse as laser engravers and document scanners. All of these devices contain the same core components which make up a laser scan system: laser source, beam expander, deflection device, and a scan lens.

If the purpose of the scan system is to record data on photo-sensitive material or to read information off the scanned plane, then relatively low power lasers operating in the visible and near-infrared spectrum find wide application. HeNe lasers with outputs of 0.5 mW to 20 mW operating at 632.8 nm are most often employed. In the recording application, if blue-sensitive material is being used, argon ion or helium-cadmium lasers make excellent choices. In marking and trimming applications, higher energy densities are often required. YAG lasers operating at 1.064  $\mu\text{m}$  and CO<sub>2</sub> lasers operating at 10.6  $\mu\text{m}$  are often used. YAG lasers have typical output powers ranging from 3 watts to 30 watts. The power required will depend on writing speed, absorptance of the material being marked, the size of the focused spot, and the efficiency of the optical system.



POST-OBJECTIVE SCANNING.



PRE-OBJECTIVE SCANNING.

A variety of mechanisms are available for deflecting the laser beam. The highest speed scanning systems often employ rotating multifaceted polygons or holographic gratings. A typical application area for these deflection devices is in graphic arts laser typesetters. Stroke writing applications such as laser marking, on the other hand, require the ability to randomly access any point within the scan field. This is usually best done by using galvanometric scan mirrors.

A beam expander is usually required in a laser scan system in order to achieve the desired system resolution. Expanding the laser beam has the effect of reducing the  $f$ /number of the scan lens which results in a smaller spot diameter and provides better resolution. Because of this beam diameter/spot diameter relationship, both beam expander and scan lens must be considered together. The laser scan lens itself is normally designed specifically to meet requirements for scan length, scan linearity, input scan angle, spot size and power loss, depth of focus, wavelength, and mechanical interface considerations.

These requirements are not unlike the requirements for any multi-element focusing objective. What makes the laser scan lens unique is the combination of a wide angular field, a flat image plane, and a linear relationship between input scan angle and image height. In addition, laser scan lenses are designed for an external aperture stop, apodized pupil illumination (non-uniform intensity distribution in the pupil), and for operation with monochromatic light (though multicolor operation is possible). This unique set of operating characteristics makes it possible for the laser scan lens system to write characters onto film, digitize text read from books, laser engrave complex figures directly onto a substrate, or perform a host of other tasks.

## SCAN LENS DESIGN

**There are seven areas that must be addressed when considering the use of a laser scan lens.**

### Scan Length

A significant difference between the design of a classical visual imaging objective and a laser scan lens is that one needs to add negative (barrel) distortion to the scan lens design to linearize the performance. This linearization is what has come to be known as the f-Theta condition and is unique to laser scan lenses.

For a distortion-free visual image, produced by a perfect photographic objective, field coverage is expressed as

$$Y = f(\text{and})$$

where  $Y$  is the image height,  $f$  is the effective focal length of the lens, and  $\theta$  is the field angle. In contrast to this, for optimum scan lens performance

$$L = 2Y = f(2\theta)$$

is true, where  $L$  is the scan length,  $f$  is the calibrated focal length of the lens, and  $\theta$  is the field angle, expressed in radians, in object space. As a result of this expression, laser scan lenses are sometimes referred to as  $L/\theta$  or  $f$ -Theta scan lenses.

## Scan Linearity

The degree to which a scan lens deviates from  $L = ZY = f \tan \theta$  is known as the residual linearity error. Accepted ways of defining this quantity include:

**Absolute Position Error** is the observed scan height minus the expected scan height. The maximum value of this error is given as the specification for the lens.

**Percent Position Error** is defined as the observed scan height, minus the expected scan height, divided by the expected scan height, and multiplied by 100 to yield a percent position error.

**Percent Velocity Error** is the velocity of the image spot at a specific field angle, minus the velocity of the image spot as it crosses the optical axis of the lens, this quantity then divided by the latter velocity value. The ratio is then multiplied by 100 to yield a percentage.

**Feature Size Error** is a measure of how well the scan system writes features of equal size across the image plane. To calculate feature size error, equal increment scan angles are input to the lens and the observed image heights recorded.

**Custom Designed Laser Scan Lenses.** — OEM customers often require laser scan lenses to be designed for their specific applications. If you would like to discuss your requirements, please contact our Rochester facility directly at **Maxter Griot Rochester**, 85 Science Parkway Rochester, NY 14620; telephone (716) 244-7220, fax (716) 244-8532.

## Findings

## Conclusions and References

Optics

## Whitman

**Prisms and  
Polarizing  
Optical Filters**

**Polymers and Composites**

**Albino and  
Eublems**

**Modul 10**  
**Option**

## High Energy Low Output

**CO<sub>2</sub> Laser  
Optics**

**Midwest Regional  
Scholarship  
Appliances**

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